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(54) Temperature control in an ultra light engine valve

Temperaturkontrolle in einem ultra leichten Brennkraftmaschinenventil

Contrôle de la température dans une soupape de moteur ultra légère

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- **PATENT ABSTRACTS OF JAPAN vol. 009 no. 311 (M-436) ,7 December 1985 & JP-A-60 145410**

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Description

The present invention relates generally to light weight poppet valves for internal combustion engines, and more particularly to the control of temperature in a valve which is of exceptionally light weight.

Internal combustion engine poppet valves are most commonly fabricated by machining, forging or extruding a solid blank of high-strength, heat resistant metal and then subjecting the blank to finish machining and/or grinding operations. In some applications, performance requirements make it necessary to provide a valve having a hollow stem into which a coolant such as sodium may be added during the fabrication process. In the prior art, such hollow stems have been formed by means such as drilling the stem or by extruding or forging the stem over a mandrel or a removable core. European patent application EP-A-619 419 discloses a poppet valve which comprises a stem element which includes an integral tip and fillet portion and a cap which is preferably welded to the stem element. The stem element is in the form of a cup having a flared open end defining the fillet region of the valve and a closed end defining the tip, and is hollow all the way to the tip; and wherein the wall section of the stem element is relatively thick in the fillet region, tapers down to a substantially uniform thickness for the rest of the length of the stem, and is again relatively thick at the tip end. The stem element is fabricated by means of a deep drawing process wherein a starting blank in the form of a sheet-like disk is subjected to a plurality of cold drawing steps which result in an elongated flared cup wherein the outer edge of the flared end and the tip end are substantially of the thickness of the starting blank. One or more keeper grooves are rolled into the hollow stem as an added step to the drawing process.

Hollow exhaust valves to which a coolant is added are known in the art, as are hollow exhaust valves which have multiple chambers for the addition of multiple coolants. The deep drawing process greatly simplifies the formation of multiple chambers in a hollow valve.

The fabrication of the valve by a deep drawing process also makes practical a valve structure which includes multiple walls with an air gap between the walls to define a thermal barrier.

Other objects and advantages of the invention will be apparent from the following description when considered in connection with the accompanying drawings, wherein;

FIG. 1 is a sectional view of an ultra light valve;
FIG. 2 is a sectional view of a prior art hollow valve;
FIGS. 3A - 3D illustrate a deep drawing process for forming ultra light valves;
FIG. 4 is a fragmentary sectional view showing a method for forming a groove in the stem region of the valve;
FIG. 5 is a sectional view taken along line 5-5 of FIG. 4;
FIG. 6 is a sectional view of a first embodiment of an ultra light valve having plural coolant chambers;
FIG. 7 is a fragmentary sectional view of a second embodiment of an ultra light valve having plural coolant chambers; and
FIG. 8 is a sectional view of an ultra light valve incorporating a thermal barrier.

Referring to **FIG. 1**, there is illustrated a poppet valve **10** comprising a stem element **12** and a cap element **14** which is welded or otherwise joined to the stem element. As described in detail in Application EP-A-619 419, the stem element **12** is formed by a cold forming process, as illustrated in **FIGS. 3A - 3D**, wherein formation of the stem progresses from a disk **12a** through a series of deep drawing steps in which plungers or mandrels **16b - 16d** are engaged with the blank while it is supported in dies **18b - 18d** to form the blank through stages designated **12b - 12d** into a shape near to the final shape shown in **FIG. 1**. Additional drawing steps are then applied to arrive at the final shape. Referring to **FIGS. 4 and 5** the stem element **12** can also be subjected to a step wherein the keeper groove **20** is formed as a part of the cold forming process. In this step, the workpiece in its early completed form is transferred to a station wherein the workpiece is received between two dies **21** and **23** which are geared or otherwise linked together to move in opposite directions, as indicated by the arrows in **FIG. 5**, to roll the workpiece between them. To form the groove **20**, the die **21** has a knurled or other high friction surface **25** formed thereon to grip the workpiece, and the die **23** has a projection **27** thereon in the form of a ramp to displace the material of the workpiece wall to form the keeper groove. Other methods of forming the groove can also be used, including a plurality of radially movable circular dies in surrounding relation to the workpiece. Because of the displacement of the material, the final steps to insure the shape of the tip end as well as to obtain the final dimensions of the stem portion are carried out after the groove rolling step. A single groove is shown herein; however, it can be appreciated that multiple grooves of varied shape can be formed if required for a particular engine design, or to provide additional stiffness. The final stem element **12** which results from the above process is characterized by an integral tip end and by a very thin wall through the length of the straight portion of the stem but wherein the thickness in the areas of the fillet and the tip respectively are essentially the thickness of the original metal sheet **12a** in **FIG. 3A**. The addition of the cap **14** results in a valve structure of extremely light weight which has a very large interior volume as compared with prior art light weight valves. A typical example of a prior art light weight, hollow valve **10'** is shown in **FIG. 2** for comparison.

FIG. 6 illustrates an embodiment of a hollow valve **10a** which takes advantage of the use of the deep drawing process to produce a thin-walled and very light

weight structure. In this embodiment the stem portion **12a** is formed in two pieces, a lower element **26** which includes the fillet region, and an upper element **28**, in which the keeper groove **20** is formed. The lower element is formed, preferably by deep drawing as illustrated in **FIGS. 3A - 3D** with an area of reduced diameter **30** over which the upper element **28** is fitted. The two elements are preferably joined by welding, and a cap **14** is applied as in the **FIG. 1** structure to provide a complete valve. The two-piece stem structure provides several desirable features. The valve assembly has a first cavity **32** which can be partially filled with a first coolant such as sodium potassium, and a second cavity **34** which can be partially filled with a second coolant such as water, whereby the first coolant cools the head portion of the exhaust valve, which is subjected to very high temperatures, and the second coolant cools the relatively lower temperature stem portion.

Another advantage of the two-piece stem design shown in **FIG. 6** is that it permits the use of different materials for the tip and fillet ends of the valve. Accordingly, a heat and corrosion resistant material such as 305 stainless steel can be used at the fillet end where high temperature corrosion resistance is an important consideration, while a hardenable alloy such as carbon steel can be used at the tip end where wear resistance and stiffness are important but heat and corrosion resistance are not. A further advantage of this configuration is that it permits the fabrication of longer valve stems than would be possible with a single piece stem element since there is a practical limit to how long a given blank can be drawn.

The embodiment illustrated in **FIG. 7** is a variation of the multiple chamber aspect of the **FIG. 6** embodiment. In this embodiment the finished valve structure **10b** is essentially the same as the **FIG. 1** embodiment. As in the **FIG. 1** embodiment a single piece stem portion **12b** is utilized; however a plug **36** is inserted in the stem after the stem is deep drawn, and is preferably retained by rolling in one or more grooves 38 similar to the keeper groove **20** by a process such as that illustrated in **FIGS 4 and 5**. The plug can also be retained by other means such as welding, the only critical requirements of the plug being that it forms a seal with the interior surface of the stem and that it be compatible with the temperature to which the valve is subjected. In the preferred embodiment illustrated the plug is aluminum and is formed in the shape shown prior to insertion. In this embodiment a first coolant can be put into the cavity **40** prior to the insertion of the plug, and a second coolant put into the cavity **42** after insertion and fixing of the plug.

The embodiment shown in **FIG. 8**, provides a valve **10c** which is made up of an inner deep drawn member **44** and an outer deep drawn member **46**. The inner member **44** includes a stem portion **12c** and a fillet portion **24a** to which the cap element **14** is attached, preferably by welding. The outer member **46** includes a stem portion **12d**, a fillet portion **24b** and a tip portion which indudes the keeper groove **20**. In this embodiment the inner and outer members **44** and **46** are formed with an air gap designated as element **48** in the fillet region. The air gap, which is preferably from 0.25 mm to 1.0 mm serves to provide a thermal conductivity barrier between the members. In the preferred embodiment the inner member **44** is in sealing relation to the outer member **46** at or adjacent to the closed end **50** of the inner member. The outer edges of the fillet portions **24a** and **24b** can also be sealed in the process of welding on the cap **14**.

In all of the embodiments illustrated herein, the wall thickness of the various deep drawn elements will vary according to the overall size of the valve and the type of engine to which it is applied. A valve of typical proportions configured as shown in **FIG. 1** for a passenger can engine application would have the following dimensions:

Head diameter	28 mm
Stem O.D.	6 mm
Stem I.D.	5 mm
Minimum wall thickness	0.5 mm
Empty weight	17 g

Claims

1. An ultra light poppet valve **(10)** for an internal combustion engine comprising a stem portion **(12)**, a cap portion (**14**), a tip portion and a flared fillet portion defining a transition region between said stem portion and said cap portion; characterized by said stem portion, tip portion and fillet portion being formed by first (**26**) and second (**28**) interfitting thin-walled cylindrical members both made from a metal sheet material and both open at one end and closed at the other end with the thin wall extending the full length of the cylindrical member including the closed end thereof; said first cylindrical member defining said fillet portion and a part of said stem portion and being formed with an area of reduced diameter (**30**) adjacent the closed end thereof; and said second cylindrical member being received over said first element and defining the remainder of said stem portion and said tip portion; said first and second cylindrical members defining first (**32**) and second (**34**) chambers within said poppet valve.

2. A valve as claimed in claim **1**, including one or more grooves (**20**) formed in said second cylindrical member adjacent the closed end thereof.

3. An ultra light poppet valve (**10**) for an internal combustion engine comprising a stem portion (**12**), a cap portion (**14**), a tip portion and a flared fillet portion defining a transition region between said stem

portion and said cap portion; said cap portion being defined by a disk-like cap member fixed to said fillet portion and said stem portion, and said tip portion and said fillet portion being defined by a one-piece thin-walled cylindrical member made from a metal sheet material which is open at the fillet end thereof and closed at the tip end; the thin wall of the stem portion extending the full length of said stem portion to the intersection of the stem portion with the tip portion; characterized by a plug element (**36**) received within said stem portion, said plug element (**36**) defining first (**40**) and second (**42**) chambers within the interior of said poppet valve, and said plug (**36**) being retained within said stem portion by deflecting the wall of said stem portion inward in the area where said plug is received.

4. A valve as claimed in claim **3** , including one or more grooves (**20**) formed in said stem portion adjacent the tip end thereof.

5. An ultra light poppet valve (**10**) as claimed in claim 1, wherein both elements (**44, 46**) comprise a flared fillet portion, said first cylindrical member (**44**) having a reduced diameter and being entirely nested within said second cylindrical element (**46**) and in sealing engagement with said second cylindrical element (**46**) but with at least a portion of its outer surface spaced from the inner surface of said second cylindrical outer element (**46**).

6. A valve as claimed in claim **5**, in which each of said inner and outer elements (**44, 46**) is defined by a one-piece, thin-walled cylindrical member which is open at the flared end thereof and closed at the tip end; the thin wall of the stem portion extending the full length of said stem portion to the intersection of the stem portion with the tip portion.

7. A valve as claimed in claim **5** including one or more grooves (**20**) formed in said outer element adjacent the tip end thereof.

8. A valve as claimed in any of claims **5, 6,** or **7** in which said inner and outer elements define first and second chambers within said valve.

Patentansprüche

1. Ultraleichtes Kopfventil (10) für einen Verbrennungsmotor mit einem Schaftteil (12), einem Kappenteil (14), einem Vorderteil und einem erweiterten Übergangsteil, der eine Übergangsregion zwischen dem Schaftteil und dem Kappenteil bildet, dadurch gekennzeichnet, daß der Schaftteil, der Vorderteil und der Übergangsteil gebildet werden durch erste (26) und zweite (28) ineinanderpassende dünnwandige zylindrische Glieder, beide hergestellt aus einem Metallblechmaterial und beide offen an einem Ende und geschlossen an dem anderen Ende, wobei sich die dünne Wand über die volle Länge des Zylinderglieds einschließlich des geschlossenen Endes davon erstreckt; wobei das erste Zylinderglied den Übergangsteil definiert und einen Teil des Schaftteils und mit einem Gebiet verminderten Durchmessers (30) ausgeformt ist und zwar benachbart zum geschlossenen Ende davon; und wobei das zweite zylindrische Glied über dem ersten Element aufgenommen ist und den Rest des Schaftteils und des Endteils definiert; wobei die ersten und zweiten zylindrischen Glieder erste (32) und zweite (34) Kammern innerhalb des Kopfventils definieren.

2. Ventil nach Anspruch 1, einschließlich einer oder mehrerer Nuten (20) gebildet oder geformt in dem zweiten zylindrischen Glied benachbart zu dem geschlossenen Ende davon.

3. Ultraleichtes Kopfventil (10) für einen Verbrennungsmotor und zwar einen Schaftteil (12), einen Kappenteil (14), einen vorderen Teil und einen sich erweiternden Übergangsteil aufweisend, der eine Übergangszone oder -region definiert zwischen dem Schaftteil und dem Kappenteil; wobei der Kappenteil durch ein scheibenförmiges Kappenglied definiert ist und zwar befestigt an dem Übergangsteil und dem Schaftteil, und wobei der Vorderteil und der Übergangsteil definiert sind durch ein einstükkiges dünnwandiges zylindrisches Glied hergestellt aus einem Metallblechmaterial, das offen ist an dem Übergangs ende davon und geschlossen an dem Vorderende; wobei die dünne Wand des Schaftteils sich über die volle Länge des Schaftteils zu dem Schnitt vom Schaftteil mit dem Vorderteil erstreckt, gekennzeichnet durch ein Stopfenelement (36) aufgenommen innerhalb des Schaftteils, wobei das Stopfenelement (36) erste (40) und zweite (42) Kammern innerhalb des Inneren des erwähnten Kopfventils definieren, und wobei der Stopfen (36) innerhalb des Schaftteils dadurch gehalten wird, daß die Wand des Schaftteils nach Innen in das Gebiet umgelegt wird, wo der Stopfen aufgenommen ist.

4. Ventil nach Anspruch 3, einschließlich einer oder mehrerer Nuten (20) geformt in dem erwähnten Schaftteil benachbart zu dem Vorderende davon.

5. Ultraleichtes Kopfventil (10) nach Anspruch 1, wobei die beiden Elemente (44, 46) einen sich erweiternden Übergangsteil aufweisen, wobei das erste Zylinderglied (44) einen verminderten Durchmesser besitzt und vollständig nestartig innerhalb des zweiten Zylinderelements (46) sitzt und zwar in Ab-

dichteingriff mit dem zweiten zylindrischen Element (46), aber mit mindestens einem Teil seiner Außenoberfläche beabstandet gegenüber der Innenoberfläche des zweiten zylindrischen Außenelements (46).

6. Ventil nach Anspruch 5, wobei jedes der inneren und äußeren Elemente (44, 46) durch ein einstükkiges dünnwandiges zylindrisches Glied definiert ist, welches an dem erweiterten Ende davon offen ist und an dem Vorderende geschlossen ist; wobei die dünne Wand des Schaftteils sich über die volle Länge des Schaftteils zum Schnitt des Schaftteils mit dem Vorderteil erstreckt.

7. Ventil nach Anspruch 5, mit einer oder mehreren Nuten (20) geformt an dem erwähnten Außenelement benachbart zu dem Vorderende davon.

8. Ventil nach einem der Ansprüche 5, 6 oder 7, wobei die Innen- und Außenelemente erste und zweite Kammern innerhalb des Ventils definieren.

Revendications

1. Une soupape en champignon ultra légère (10) pour un moteur à combustion interne comprenant une partie de tige (12), une partie de chapeau (14), une partie de pointe et une partie de congé de raccordement évasée formant une région de transition entre ladite partie de tige et ladite partie de chapeau, caractérisée en ce que lesdites partie de tige, partie de pointe et partie de congé de raccordement sont formées par des premier (26) et second (28) organes cylindriques à paroi mince engagés l'un dans l'autre fabriqués tous deux en une matière en feuille métallique et tous deux ouverts à une extrémité et fermés à l'autre extrémité, la mince paroi s'étendant sur toute la longueur de l'organe cylindrique y compris l'extrémité fermée de ce dernier, ledit premier organe cylindrique formant ladite partie de congé de raccordement et une partie de ladite partie de tige et étant muni d'une région (30) de plus petit diamètre au voisinage de son extrémité fermée; et ledit second organe cylindrique étant reçu sur ledit premier élément et formant le reste de ladite partie de tige et ladite partie de pointe; lesdits premier et second organes cylindriques délimitant des première (32) et seconde (34) chambres à l'intérieur de ladite soupape en champignon.

2. Une soupape telle que revendiquée dans la revendication 1, comprenant une ou plusieurs gorges (20) formées dans ledit second organe cylindrique au voisinage de l'extrémité fermée de ce dernier.

3. Une soupape en champignon ultra légère (10) pour un moteur à combustion interne comprenant une partie de tige (12), une partie de chapeau (14), une partie de pointe et une partie de congé de raccordement évasée formant une région de transition entre ladite partie de tige et ladite partie de chapeau, ladite partie de chapeau étant constituée par un organe formant chapeau en forme de disque fixé à ladite partie de congé de raccordement et à ladite partie de tige, et ladite partie de pointe et ladite partie de congé de raccordement étant formées par un organe cylindrique à mince paroi en une seule pièce fabriqué en une matière en feuille métallique qui est ouvert à son extrémité de congé de raccordement et fermé à son extrémité de pointe; la mince paroi de la partie de tige s'étendant sur toute la longueur de ladite partie de tige jusqu'à l'intersection de la partie de tige avec la partie de pointe; caractérisée par un élément formant bouchon (36) reçu à l'intérieur de la dite partie de tige, ledit élément formant bouchon (36) délimitant des première (40) et seconde (42) chambres à l'intérieur de ladite soupape en champignon et ledit bouchon (36) étant retenu à l'intérieur de ladite partie de tige par déformation de la paroi de ladite partie de tige vers l'intérieur dans la région dans laquelle ledit bouchon est reçu.

4. Une soupape telle que revendiquée dans la revendication 3, comprenant une ou plusieurs gorges (20) formées dans ladite partie de tige au voisinage de l'extrémité de pointe de cette dernière.

5. Une soupape en champignon ultra légère (10) telle que revendiquée dans la revendication 1, dans laquelle les éléments (44, 46) comportent tous deux une partie de congé de raccordement évasée, ledit premier organe cylindrique (44) ayant un plus petit diamètre et étant entièrement logé à l'intérieur dudit second élément cylindrique (46) mais avec au moins une partie de sa surface extérieure espacée de la surface intérieure dudit second élément cylindrique extérieur (46).

6. Une soupape telle que revendiquée dans la revendication 5, dans laquelle chacun desdits éléments intérieur et extérieur (44, 46) est constitué par un organe cylindrique à paroi mince en une seule pièce qui est ouvert à son extrémité évasée et fermé à son extrémité de pointe; la mince paroi de la partie de tige s'étendant sur toute la longueur de ladite partie de tige jusqu'à l'intersection de la partie de tige avec la partie de pointe.

7. Une soupape telle que revendiquée dans la revendication 5 comportant une ou plusieurs gorges (20) formées dans ledit élément extérieur au voisinage de son extrémité de pointe.

8. Une soupape telle que revendiquée dans l'une

quelconque des revendications 5, 6 ou 7 dans laquelle lesdits éléments intérieur et extérieur délimitent des première et seconde chambres à l'intérieur de ladite soupape.

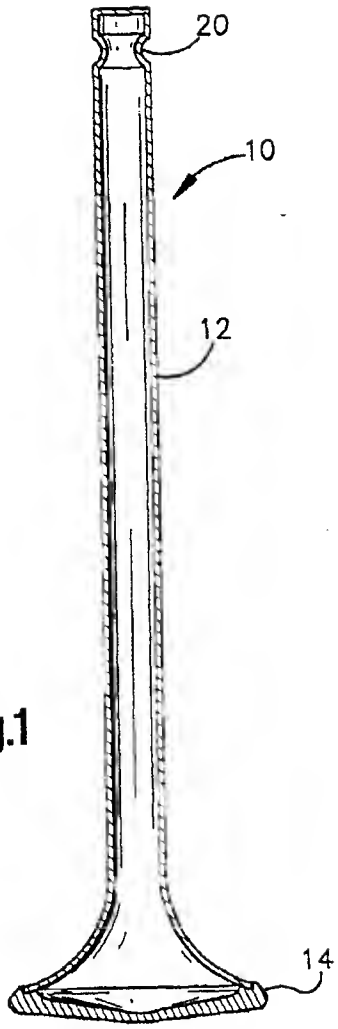

Fig.1

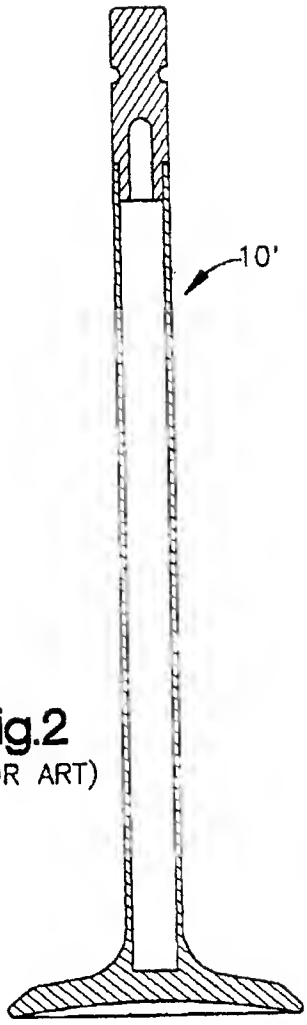

Fig.2
(PRIOR ART)

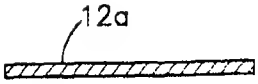

Fig.3A

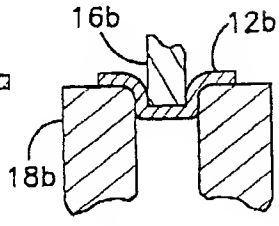

Fig.3B

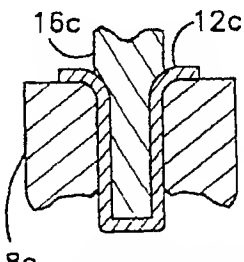

Fig.3C

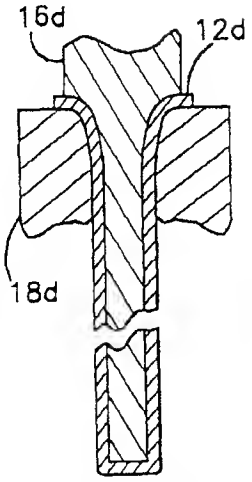

Fig.3D

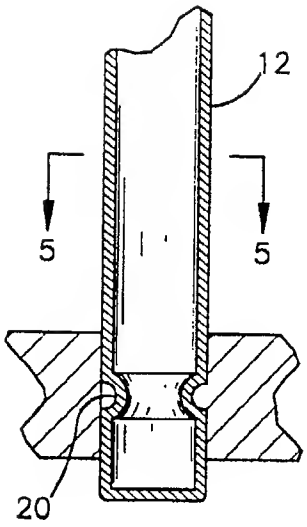

Fig.4

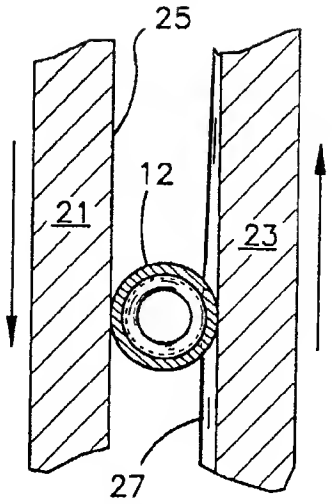

Fig.5

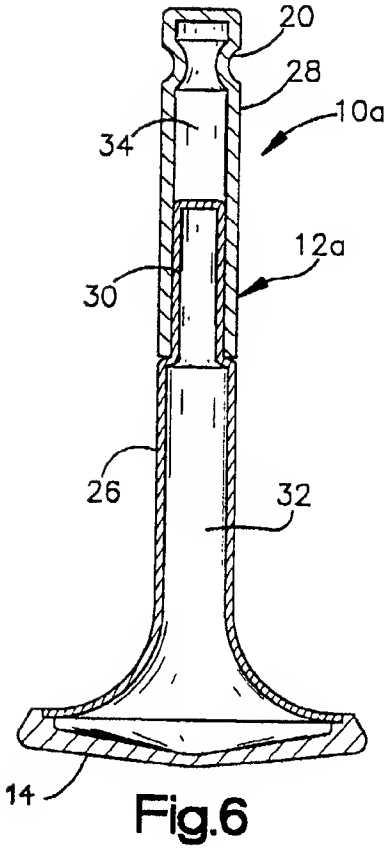

Fig.6

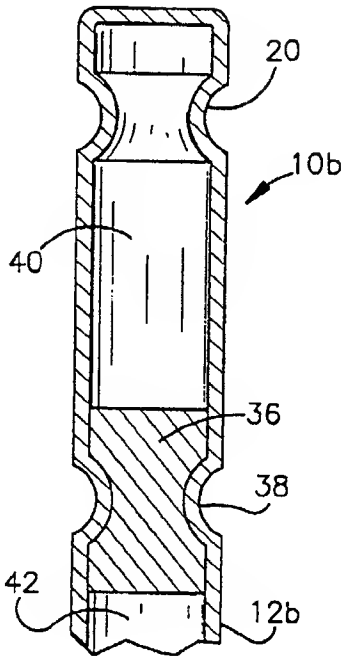

Fig.7

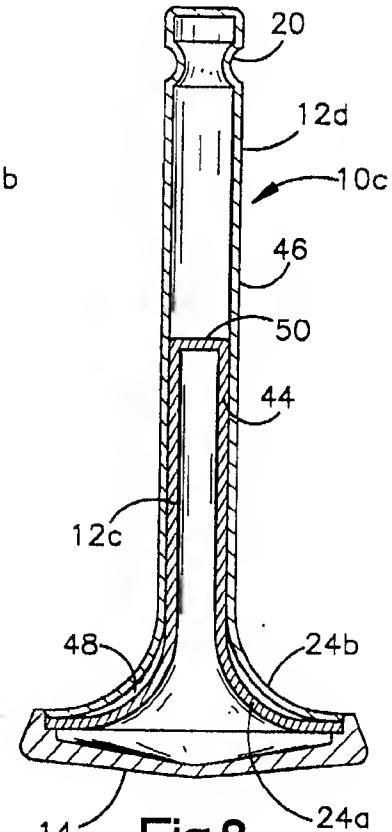

Fig.8

Temperature control in an ultra light engine valve

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Inventor(s): BONESTEEL DAVID LOUIS [US] +
Applicant(s): EATON CORP [US] +
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- European: B23P15/00B1; F01L3/02; F01L3/14; F01L3/20
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Priority number(s): US19940328800 19941031

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JP8210112 (A)
DE69504273 (T2)
CN1132307 (A)
more >>

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US2070102 (A)
US2065049 (A)

Abstract of **EP 0709552 (A2)**

An ultra light weight poppet valve (10) which includes elements for controlling the temperature of the valve during operation. The valve is of the type which is formed as an elongated cup having a flared open end to which a cap (14) is fixed and in which an extremely thin-wall section (12) is maintained all the way to a closed tip end. Temperature control elements include multiple thin-walled elements (26, 28) in nesting relationship to define multiple interior chambers (32, 34), and a plug member (36) received within the stem portion of the valve and maintained in place by inwardly deflecting the stem portion.

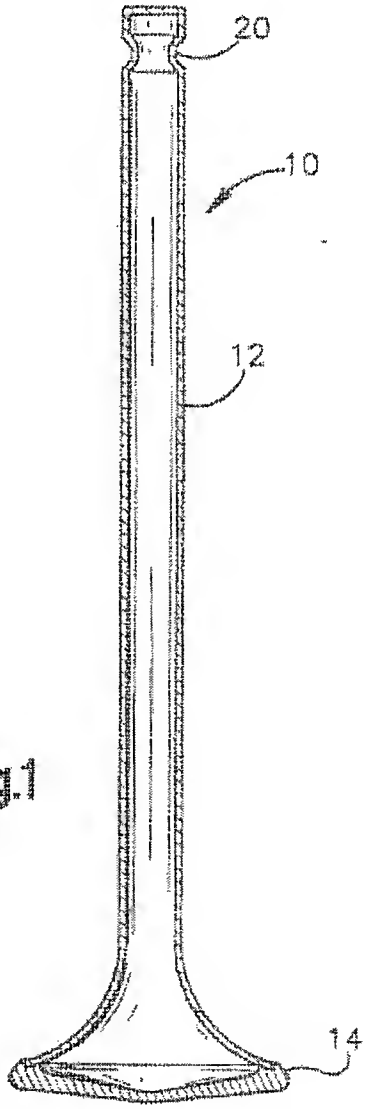

Fig.1